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(54) IMPROVEMENTS RELATING TO SPRAYING DEVICES

(71) We, TOYO AEROSOL INDUSTRY CO. LTD., a Japanese corporation, of No. 28–24, Tamagawa 2-chome, Oota-ku, Takyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:–

The present invention relates to a spraying device of the piston type.

Conventional spraying devices for dispensing contents in the spray state are divided into two types. More specifically, there have heretofore been used pump-type spraying devices in which a piston is operated by a hand or finger to apply a pressing force to the content and by this pressing force the content is discharged in the spray state and aerosol-type spraying devices in which a high pressure gas is filled in a pressure container charged with the content and the content is sprayed out by the action of this high pressure gas.

In the former type spraying devices, since no high pressure gas is used, there is not a danger of explosion or the like, but depending on the intenstiy of the pressing force or the capacity of the piston, the size of sprayed particles is changed or the spraying efficiency is degraded. In the latter aerosol type spraying devices using a high pressure gas, the foregoing defect involved in the pump type spraying devices can be overcome and eliminated, but they are still defective because explosion is often caused by careless handling and formation of a pressure container costs a great deal.

Under such background, we made various research works and investigations with a view to improving the pump-type spraying device and have now succeeded in developing a novel pump-type spraying device which has merits of both the conventional pump-type and aerosol-type spraying devices, namely a spraying device in which the possibility of occurrence of explosion and other accidents is reduced to a minimum and a very high spraying efficiency is attained.

It is a primary object of the present invention to provide a spraying device comprising an air-tight vessel which has not been used at all in any of the conventional spraying devices, in which the atmosphere in the air-tight vessel is maintained at a low pressure.

Another object of the present invention is to provide a spraying device comprising such air-tight vessel, in which a low pressure gas is preliminarily filled so as to facilitate maintenance of a low pressure in the atmosphere in the interior of the air-tight vessel.

Still another object of the present invention is to provide a spraying device comprising such air-tight vessel, in which a piston having a specific structure is built in the air-tight vessel and a good spray condition is attained by elevating the spraying pressure by the piston operation.

A further object of the present invention is to provide a spraying device comprising such air-tight vessel, in which a pressure-receiving compartment and a pressurizing compartment are formed successively in a housing to be built in the air-tight vessel so that a good spray condition is attained only when the spraying pressure is elevated to a predetermined level by the piston operation.

A still further object of the present invention is to provide a spraying device comprising such air-tight vessel having the above-mentioned pressure-receiving and pressurizing compartments, in which both the compartments are arranged to have a specific structure and the piston and non-return valve are combined with these compartments so that the spraying capacity is further enhanced.

A still another object of the present invention is to provide a spraying device in which a

volatile component can be filled and hence, the volatility of the sprayed material can be remarkably enhanced over the volatility of the material sprayed according to the conventional pump-type spraying device, whereby dry spray with a good drying property can be attained and the amount of a pressurized gas to be used can be remarkably reduced.

The foregoing and other objects and characteristics of the present invention will be apparent from the following detailed description made by reference to the accompanying drawing.

Figure 1 is a front view of the spraying device showing the section of the air-tight vessel,

Figure 2 is an enlarged view showing the longitudinal sections of main members of the spraying device,

Figure 3 is an enlarged view showing the longitudinal sections of main members of the spraying device according to still another embodiment and

Figure 4 is an enlarged view showing the longitudinal sections of main members of the spraying device according to a further embodiment of the present invention.

The spraying device of the present invention will now be described in detail. In the illustration given hereinafter, by the term "content" is meant the combination of a liquid, powder or other material to be ejected with a pressurized gas, and by the term "low pressure" is meant a pressure under which no sufficient spray condition can be attained by the ejecting pressure of the content or pressurized gas per se.

Embodiments shown in Figures 1 to 4 will now be described, in which same members are represented by same referential numerals.

Referring now to Figures 1 and 2 a mounting cap 101 is air-tightly fixed to the opening of an air-tight vessel 2 filled with a pressurized gas of a low pressure of up to 2 Kg/cm^2 as measured at 33°C and a material 1 to be ejected, and a housing 103 is fixed to the inner face of the mounting cap 101 through a gasket 102. Collapsible bellows members 104 and 105 comprise confronting openings 104 and 105 almost at the center of the housing 103 in the longitudinal direction thereof and opening flanges 108 and 109 fixed to a fitting portion 112 of top member 110 and lower member 111 of the housing 103. A pressure-receiving compartment 113 is formed in one bellows member 104 located at a lower position and a pressurizing compartment 114 having a diameter larger than that of the pressure-receiving compartment 113 is formed in the other bellows member 105. The lower end face of a stem 115 is fixed to the top end of said other bellows member 105, and the stem 115 pierces the gasket 102 and mounting cap 101 and the end portion thereof is projected outwardly of the air-tight vessel, so that when an external pressing force is applied to the stem 115, the pressurizing compartment 114 is pressurized. A push button 116 is fixed to the upper end of the stem 115, and a nozzle 117 is disposed on one outer side face of the push button 116 and a conduit 118 communicated with the nozzle 117 is connected to a content-ejecting opening 119 of the stem 115. A pressure-receiving member 120 is disposed to press a closing portion 122 formed by a gasket 121 toward the content-ejecting opening 119 by the pressing force of a spring 123 so that the opening 119 is opened or closed. An insertion lever 125 slidably inserted in a conduit 124 in the stem 115 is fixed to a holding frame 127 having an opening 126 exposed to the interior of the pressurizing compartment 114, and a non-return valve 128 capable of opening only when the pressure is reduced in the pressurizing compartment 114 is fixed to the holding frame 127. A content passage 130 is formed in a fixed pipe 131 and is communicated with a valve seat 129 of the non-return valve 128, and this fixed pipe 131 is fixed to the lower wall 132 of said one bellows member 104. The content passage 130 is communicated with the housing 103 through a communicating hole 133. A dip tube 134 is disposed to communicate the housing 103 with the interior of the air-tight vessel 2 and introduce the content into the housing 103.

In the spraying device having the above structure, when the push button 116 is depressed, said other bellows member 105 is deformed in the direction of contraction to pressurize the pressurizing compartment 114. Simultaneously, also the pressure-receiving member 120 pressed through the closing portion 122 toward the content-ejecting opening 119 by the spring 123 is pressed by the stem 115 and forcibly brought down against the restoring force of the spring 123. Further, said one bellows member 104 undergoes the pressurizing force of the pressurizing compartment 114 and is pressed by the fixed pipe 131, whereby the bellows member 104 is elongated and brought down. Since the diameter of the pressure-receiving compartment 113 constructed by said one bellows member 131 is smaller than the diameter of the pressurizing compartment 114, the contracting force of the pressurizing compartment 114 caused by pressing of the stem 115 is amplified by this difference of the diameter and the amplified contracting force is conveyed to the pressure-receiving compartment 113. When this difference of the contracting pressing force exceeds the restoring force of the spring 123, the pressure-receiving member 120 having the lower end fixed to said one bellows member 104 is brought down toward the pressure-receiving compartment 113 by the elongating force of said one bellows member 104 to open the content-ejecting

opening 119 of the stem 115. Accordingly, the content (the gas at the initial operation) stored in the pressurizing compartment 114 and pressure-receiving compartment 113 is sprayed out from the nozzle 117 of the push button 116 by the accumulated pressurizing force.

Since not only the material to be ejected but also a pressurized gas of a low pressure of up to 2 Kg/cm² as measured at 35°C is filled as the content, in the above spraying operation the content is ejected by the ejecting force comprising the above-mentioned pressurizing force and the pressure of the pressurized gas, and the material to be ejected is finely divided by the low pressure gas contained therein to enhance the atomizing effect. As a result, an excellent spraying effect can be attained.

When the pressurizing force in the pressurizing compartment 114 is reduced by this spraying operation, the restoring force of the spring 123 overcomes the pressurizing force and the closing portion 122 of the pressure-receiving member 120 is pressed to the content-ejecting opening 119 of the stem 115 to stop ejection of the content. Simultaneously, the non-return valve 128 is opened because of reduction of the pressure in the pressurizing compartment 114 the content 1 is discharged from the air-tight vessel 2 and passed through the dip tube 134, communicating hole 133 and content passage 130 and is introduced into the pressurizing compartment 114 and pressure-receiving compartment 113 from the valve seat 129 and opening 126. During this introduction of the content and the above-mentioned spraying operation, the bellows members 104 and 105 are contracted to generate vibrations. Accordingly, when powder or other particulate material is selected as the material to be ejected, the powder or the like is shaken in the pressure-receiving compartment 113 and pressurizing compartment 114, and hence, occurrence of an undesirable phenomenon that the powder or the like adheres to the bellows members 104 and 105 or is kept resident in the pressure-receiving compartment 113 and pressurizing compartment 114 can be effectively prevented but the powder or the like can be ejected in a good spray condition. In the normal state except the time of the spraying operation, the air-tight vessel is separated air-tightly from the outside thereof by the gasket 102 and bellows members 104 and 105. Leakage of the gas from the air-tight vessel, therefore, can be effectively prevented and good atomizing and spraying effects can be attained until all the content is discharged.

Another embodiment of the spraying device of the present invention will now be described by reference to Figure 3.

Referring to Figure 3, a housing 135 is fixed to a mounting cap 101 through a gasket 102, and the diameter of the portion of the housing 135 below the substantial center in the longitudinal direction thereof is reduced through a stepped part 136. A pressure-receiving piston 137 is slidably mounted on this small-diameter portion and a pressure-receiving compartment 138 is formed in the pressure-receiving piston 137. A pressurizing compartment 139 having a diameter larger than that of the pressure-receiving compartment 138 is formed in the housing 135 and a pressurizing piston 140 is slidably mounted in the interior of the pressurizing compartment 139. An air-tight piston 141 is disposed integrally with the pressurizing piston 140 so that it is cooperative therewith, and this piston 141 is air-tightly contacted with the inner circumferential face of the housing 125. One end of a stem 142 is integrally fixed to the air-tight piston 141, and the other end of the stem 142 is projected outwardly of the air-tight vessel 2 and is provided with a push button 116 having a nozzle 117 communicated with a content-ejecting opening 119 as in the foregoing embodiment shown in Figure 5. A pressure-receiving member 143 has a closing portion 122 closely pressed to the content-ejecting opening 119 by a spring 123 interposed between the bottom wall 144 of the housing 135 and the pressure-receiving piston 137, so that the content-ejecting opening 119 is freely opened and closed, and this pressure-receiving member 143 is fixed through a holding frame 145 to a fixed pipe 131 formed integrally with the pressure-receiving piston 137. A non-return valve 146 is disposed in the fixed pipe 131 so that it is opened only when the pressure in the pressurizing compartment 139 is reduced, and this non-return valve 146 is connected to the pressurizing compartment 139 through an opening 153 of the holding frame 145.

In the present embodiment having the above structure, when the push button 116 is depressed, as in the foregoing embodiment shown in Figure 2 the difference of the pressure caused by the difference of the diameter between the pressurizing compartment 139 and the pressure-receiving compartment 138 exceeds the restoring force of the spring 123 to open the content-ejecting opening 119 of the stem 142, and the content is thus ejected. Since air-tightness is kept in the housing by the pressurizing piston 140 and air-tight piston 141, leakage of the gas from the air-tight vessel is prevented and the content can be ejected in a good spray condition in the form of fine particles until all the content is discharged. Moreover, since the pressurizing compartment 139 is formed to have a smooth surface, this embodiment is especially suitable for ejecting liquid materials.

A further embodiment of the spraying device of the present invention will now be described by reference to Figure 4.

Referring to Figure 4, an air-intercepting member 147 comprises a top end annular flange 149 inserted and fixed between the top ends of gasket 102 and housing 148. This air-intercepting member 147 is composed of a collapsible air-tight material such as a bellows member, and the lower end of the air-intercepting member 147 is inserted and fixed between a pressurizing piston 150 slidably mounted on an inner circumferential face of the housing 149 and a stem 151, so that a gasified gas leaking from a pressurizing compartment 152 through the pressurizing piston 150 is prevented from leaking to the outside of the air-tight vessel. In this embodiment, such air-intercepting member 147 is disposed instead of the air-tight piston 141 used in the embodiment shown in Figure 3, and by this arrangement, portions where contacts and frictions are caused when the push button 116 is depressed are reduced and diminished, whereby the pressing and spraying operation can be accomplished by a weaker force. Other structural elements and their functions are substantially the same as those in the embodiment shown in Figure 3.

The present embodiment illustrated in Figures 1 to 4 is characterized in that an air-tight vessel is employed and the atmosphere is kept in the lowly pressurized state, and preferably, a pressurized gas maintained at a low pressure is filled in the air-tight vessel together with a liquid, powder or other material to be ejected. By virtue of this characteristic feature, various advantages such as mentioned below can be attained.

(1) Since the risk of explosion is substantially eliminated, a pressure-resistant structure is unnecessary.

(2) Since the air-tight vessel is employed, a volatile content can be filled, and the spraying device can be used in the same manner as an aerosol-type spraying device and a similar spraying effect or condition can be attained.

(3) Spraying is accomplished by the synergistic action of the mechanical pressurization of the piston and the pressure of the content per se. Accordingly, the disadvantage involved in the conventional pump-type spraying device, namely the disadvantage that the spraying condition is remarkably changed depending on the intensity of the pressing force applied to the pump, can be eliminated, and therefore, the content can be sprayed in a predetermined amount with a high atomizing effect and a good spraying condition can always be attained.

(4) The spraying operation is assisted by mechanical pressing means, the amount of the pressurized gas to be used can be remarkably reduced.

Experiment

Various materials to be ejected and pressurized gases, as shown in Table 1, were filled in an air-tight vessel shown in Figure 3. The inner capacity of the air-tight vessel was 300 cc, and 200 cc, of the content (the material to be sprayed and the pressurized gas) was filled therein. In each case, a low pressure as shown in Table 1 was maintained in the air-tight vessel, and the material could be sprayed in a predetermined amount with a high atomizing effect and a good spray condition could be attained.

Table 1

Test No.	Kind of Spray	Material to Be Ejected (% by weight)	Pressurized Gas (% by weight)	Pressure in Air-Tight Vessel (Kg/cm^2 at 100°F.)
1	Hair spray	acrylic resin, 3.0 polypeptide, 0.5 alcohol, 86.5 perfume, suitable amount	Tetrafulorodichloro-ethane, 10.0	1.2
2	Hair spray	PVP/VA, 2.0 I.P.M., 2.0 Ethyl alcohol 86.0	Iso-butane, 10.0	1.7
3	Hair conditioner	Silicone oil, 1.0 Lanoline alcohol, 3.0 I.P.M., 1.0 Ethyl alcohol 75.0	Iso—butane, 10.0 Iso—pentane, 10.0	1.9
4.	Hair-treating composition	Mineral oil, 25.0 Lanoline alcohol, 2.0 Iso—pentane, 30.0 P.O.E. laury alchol ether, 3.0 Ethyl alcohol, 30.0	Tetrafulorodichloro ethane, 10.0	2.1
5	Colonge	Ethyl alcohol, 87.0 Perfume, 3.0	Iso-butane, 10.0	1.7
6	Room deodrant	Lauryl methaacrylate, 5.0 Perfume, 1.0 Ethyl alcohol, 76.0 Propylene glycol, 1.5 Triethylene glycol, 1.5	Iso-butane, 15.0	2.3
7	Cleaner	P.O.E. nonyl phenol, 2.0 Postassium pyrophos-phate, 6.0 Cellosolve, 10.0 Iso-propyl alcohol, 4.0 Distilled water, 90.0	Iso-butane, 10.0	1.8
8	Antiperspirant	Rehydrol (A.S.C.) [product of Reheis Chemical Co.), 3.0 Gafce RM—510 [product of General Anilline Co.), 0.5 Ethyl alcohol 94.5	Carbon dioxide, 2.0	1.6

As will be apparent from the foregoing illustration, in each of the foregoing embodiments shown in Figures 2 to 4, since a low pressure gas is filled in an air-tight vessel together with a material to be ejected, sprayed particles can be atomized much more finely than in the conventional pump-type spraying devices and the spraying efficiency can be remarkably enhanced. Moreover, since the gas to be used is maintained at a relatively low pressure, the risk of explosion can be reduced to a minimum, and spraying and storage can be done with safety. Still further, since the air-tight vessel is shut from the outside air-tightly except at the spraying operation, wasteful leakage of the gasified gas is prevented and spraying of fine particles of the content can be accomplished in a good condition until all the content is discharged.

The pump that can be used in the spraying device of the present invention is not limited to one specifically illustrated in the drawing, but any of pumps improved so that air-tightness can be maintained may be used in the present invention.

In the present invention, as the "low pressure gas", there can be used, for example, compressed gases of carbon dioxide and nitrogen suboxide, solvents having a boiling point lower than 50°C and liquefied gases.

WHAT WE CLAIM IS:-

1. A spraying device comprising an air-tight vessel supporting a finger actuated piston pump for dispensing the contents of the vessel in which a liquid or other material to be ejected and a pressurized gas are filled as the contents in the air-tight vessel and in which the pressure in the air-tight vessel is maintained at a low level such that the contents cannot be dispensed merely by the ejecting pressure of the contents per se.

2. A spraying device as set forth in claim 1, wherein the pressure of the pressurized gas is maintained at such a low level that no sufficient spray condition can be attained by the ejecting pressure of the pressurized gas per se.

3. A spraying device as set forth in claim 1, wherein a housing is formed in said air-tight vessel, and a pressure-receiving compartment and a pressurizing compartment are formed in succession in said housing, said pressurizing compartment having a diameter larger than that of the pressure receiving compartment and being shut air-tightly from the outside of the air-tight vessel in the normal state and said pressurizing compartment being arranged so that a pressure can be applied to said pressurizing compartment by the pressing force of a stem slidably projected from the housing to the outside of the air-tight vessel; a closing portion formed at one end of a pressure-receiving member fixed in the pressure-receiving compartment and capable of moving in the housing co-operatively with the pressurizing operation of the pressurizing compartment is brought in contact with a content-ejecting opening of the stem by the pressing force of a spring so that said closing portion can close and open said content-ejecting opening; and wherein said content-ejecting opening is connected to the interior of said air-tight vessel through a non-return valve which is opened only when the pressure in the pressuring compartment is reduced and through said closing portion of the pressure-receiving member.

4. A spraying device as set forth in claim 3 wherein each of said pressure-receiving compartment and said pressurizing compartment is composed of a collapsible bellows member.

5. A spraying device as set forth in claim 1 wherein a housing is formed in said air-tight vessel, and a pressure-receiving compartment having a pressure-receiving piston disposed therein and a pressurizing compartment are formed in succession in said housing, said pressurizing compartment having a diameter larger than that of the pressure-receiving compartment and being shut air-tightly from the outside of the air-tight vessel in the normal state by an air-tight piston disposed in the pressurizing compartment and said pressurizing compartment including a pressurizing piston slidably contained therein and co-operative with said air-tight piston and being arranged so that a pressure can be applied to said pressurizing compartment by the pressing force of a stem slidably projected from the housing to the outside of the air-tight vessel; a closing portion formed at one end of a pressure-receiving member fixed to the pressure-receiving piston in the pressure-receiving compartment and capable of moving in the housing co-operatively with the pressurizing operation of the pressurizing compartment is brought in contact with a content-ejecting opening of the stem by the pressing force of a spring so that said closing portion can close and open said content-ejecting opening; and wherein said content-ejecting opening is connected to the interior of said air-tight vessel through a non-return valve which is opened only when the pressure in the pressuring compartment is reduced and through said closing portion of the pressure-receiving member.

6. A spraying device as set forth in claim 1 wherein a housing is formed in said air-tight vessel, and a pressure-receiving compartment having a pressure-receiving piston disposed therein and a pressurizing compartment including a pressurizing piston slidably contained therein are formed in succession in said housing, said pressurizing compartment having a

diameter larger than that of the pressure-receiving compartment and being shut air-tightly from the outside of the air-tight vessel in the normal state by a collapsible air-tight member covering a pressing stem in the housing and said pressurizing compartment being arranged so that a pressure can be applied to said pressurizing compartment by the pressing force of said stem slidably projected from the housing to the outside of the air-tight vessel; a closing portion formed at one end of a pressure-receiving member fixed to the pressure-receiving piston in the pressure-receiving compartment and capable of moving in the housing co-operatively with the pressurizing operation of the pressurizing compartment is brought in contact with a content-ejecting opening of said stem by the pressing force of a spring so that said closing portion can close and open said content-ejecting opening; and wherein said content-ejecting opening is connected to the interior of said air-tight vessel through a non-return valve which is opened only when the pressure in the pressuring compartment is reduced and through said closing portion of the pressure-receiving member.

7. A spraying device, substantially as described with reference to, and as shown, in the accompanying drawings.

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4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

FIG.1

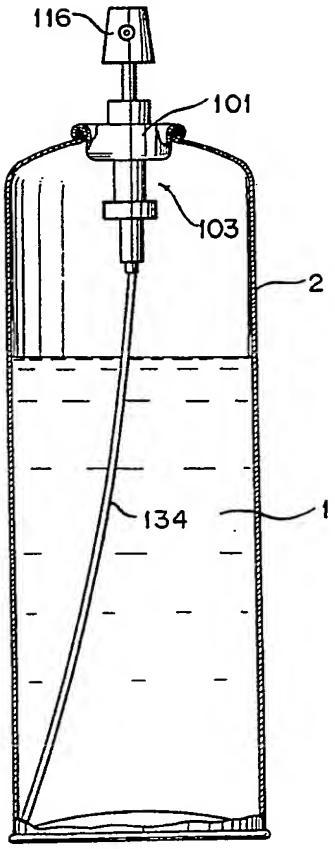

FIG.2

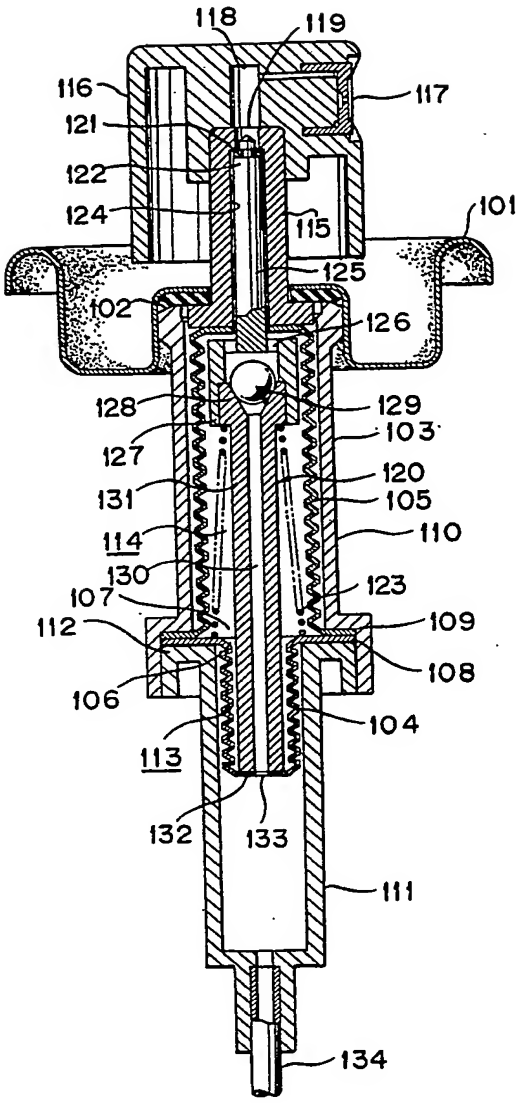
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FIG.3

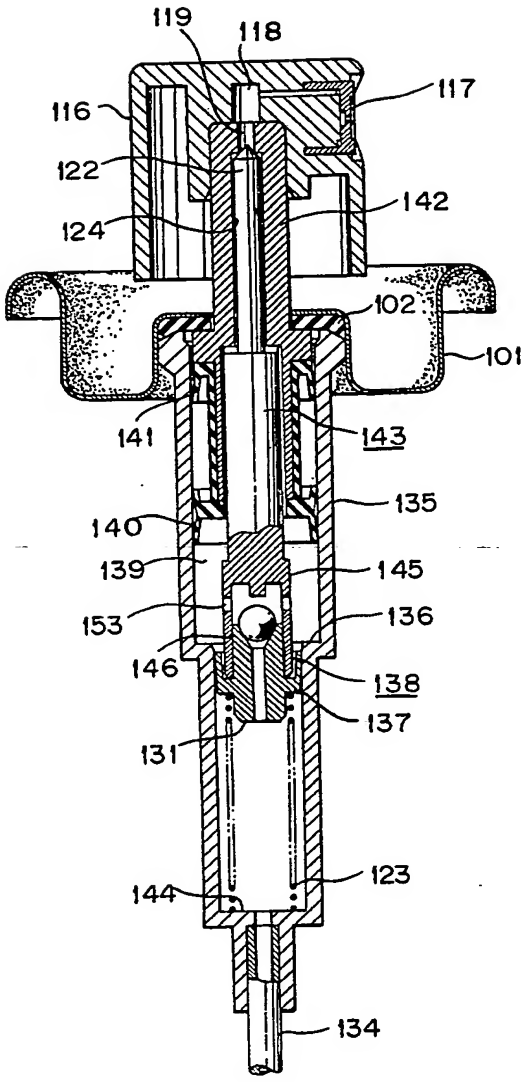
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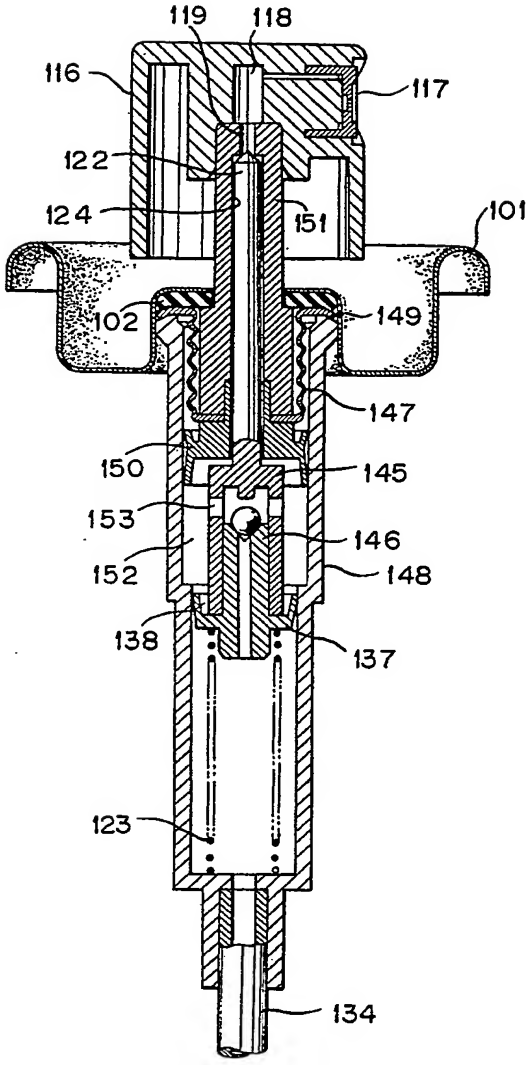
FIG.4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